

CLAIMS

1. A method of determining at least one parameter of a model, the model providing information about a position of an object, the object being provided with a plurality of alignment marks of which desired positions are known, the method comprising:

measuring a plurality of positional parameters for each of the plurality of alignment marks,

determining the at least one parameter of the model, based on the measured plurality of positional parameters,

wherein the plurality of positional parameters for each of the plurality of alignment marks are weighted with weighing coefficients, and

wherein said determining the at least one parameter of the model includes determining the numerical value of at least one of the weighing coefficients together with the at least one parameter of the model.

2. The method according to claim 1, wherein the at least one parameter of the model includes at least one of translation, rotation, and expansion.

3. The method according to claim 1, wherein the plurality of alignment marks are formed as diffractive elements, and

wherein the plurality of positional parameters are determined based on diffraction lines generated by projecting an alignment beam to at least one of the plurality of alignment marks.

4. The method according to claim 1, wherein the plurality of alignment marks includes at least one multigrating.

5. The method according to claim 1, wherein said determining the at least one parameter of the model of the object includes determining a least-squares solution of an expression based on desired and measured positions of at least one of the plurality of alignment marks.

6. The method according to claim 1, wherein the at least one parameter of the model is solved by minimizing the expression

$$\sum_{\forall i} \sqrt{(x_{meas,i} - x_{nom})^2 + (y_{meas,i} - y_{nom})^2}$$

for the plurality of alignment marks,

where $x_{meas,i}$ and $y_{meas,i}$ denote measured positions of the alignment marks based on an i-th positional parameter in an x-direction and y-direction, respectively; and x_{nom} and y_{nom} denote desired positions in the x- and y-direction, respectively.

7. The method according to claim 1, wherein said determining the at least one parameter of the model of the object includes setting the value of a weighing coefficient to zero when the signal strength of a corresponding positional parameter is below a certain threshold.

8. The method according to claim 1, wherein the object is a substrate.

9. The method according to claim 1, said method further comprising: subsequent to said determining the at least one parameter of the model of the object, projecting a patterned beam of radiation onto a target portion of the object.

10. The method according to claim 9, wherein said determining the numerical value of each weighing coefficient is based on measurements of at least one object, and

wherein the method further comprises using the determined numerical value of at least one of the weighing coefficients during determination of the at least one parameter of the model for at least one other object.

11. A lithographic apparatus comprising:
a projection system configured to project a patterned beam of radiation onto a target portion of a substrate,
a sensor;
a processing unit arranged to communicate with the sensor; and

a beam generator arranged to project an alignment beam to at least one of a plurality of alignment marks, of which desired positions are known,

wherein the sensor is arranged to measure positional parameters for each of the plurality of alignment marks based on the projected alignment beam and to transfer the measured positional parameters to the processing unit, and

wherein the processing unit is arranged to determine at least one parameter of a model providing information about a position of the substrate, based on the measured positional parameters, and

wherein the measured positional parameters are weighted with weighing coefficients, and

wherein the processing unit is arranged to determine a numerical value of at least one of the weighing coefficients together with the at least one parameter of the model.

12. The lithographic apparatus according to claim 11, wherein the at least one parameter of the model includes at least one of translation, rotation, and expansion.

13. The lithographic apparatus according to claim 11, wherein the plurality of alignment marks are formed as diffractive elements.

14. The lithographic apparatus according to claim 11, wherein the processing unit is arranged to determine the at least one parameter of the model based on a least-squares solution of an expression based on desired and measured positions of at least one of the plurality of alignment marks.

15. The lithographic apparatus according to claim 11, wherein the processing unit is arranged to set the value of a weighing coefficient to zero when the signal strength of a corresponding positional parameter is below a certain threshold.

16. The lithographic apparatus according to claim 11, wherein the apparatus is further configured to project a patterned beam of radiation onto a target portion of the substrate based on the at least one parameter of the model.

17. The lithographic apparatus according to claim 11, wherein said processing unit is arranged to determine the numerical value of at least one of the weighing coefficients based on measurements of at least one substrate, and

wherein the processing unit is arranged to use the determined numerical value of at least one of the weighing coefficients during a determination of the at least one parameter of the model for at least one other substrate.

18. A method of determining a value for a parameter of a model, the model providing information about a position of an object, the method comprising:

obtaining a plurality of measured positions for each of a plurality of alignment marks on the object,

solving an expression to obtain the value for the parameter of the model, the expression being based on (1) the plurality of measured positions, (2) at least one desired position for each of the plurality of alignment marks, and (3) a plurality of weighing coefficients, each weighing coefficient corresponding to at least one of the plurality of measured positions,

wherein a value of at least one of the weighing coefficients is based on the plurality of measured positions and the at least one desired position for each of the plurality of alignment marks.

19. The method according to claim 18, wherein solving the expression includes calculating a least-squares solution of the expression.

20. The method according to claim 18, wherein the value of at least one of the weighing coefficients is based on the value for the parameter of the model.

21. The method according to claim 18, wherein the parameter of the model includes at least one of translation, rotation, and expansion.

22. The method according to claim 18, wherein obtaining a plurality of measured positions for each of a plurality of alignment marks includes directing a beam at an alignment mark and measuring at least a portion of a diffraction pattern.